Network Technologies Workshop
RARE - Router for Academia, Research & Education

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Members of GN5-2 WP6T1-RARE

Network Technologies Workshop

19 March 2025

Agenda

- Presentation of the group
- Aim of the task
- Latest activities
- Future directions

Presentation of the RARE group

RARE (Router for Academia, Research & Education) is an ongoing effort under the GÉANT 5th programme

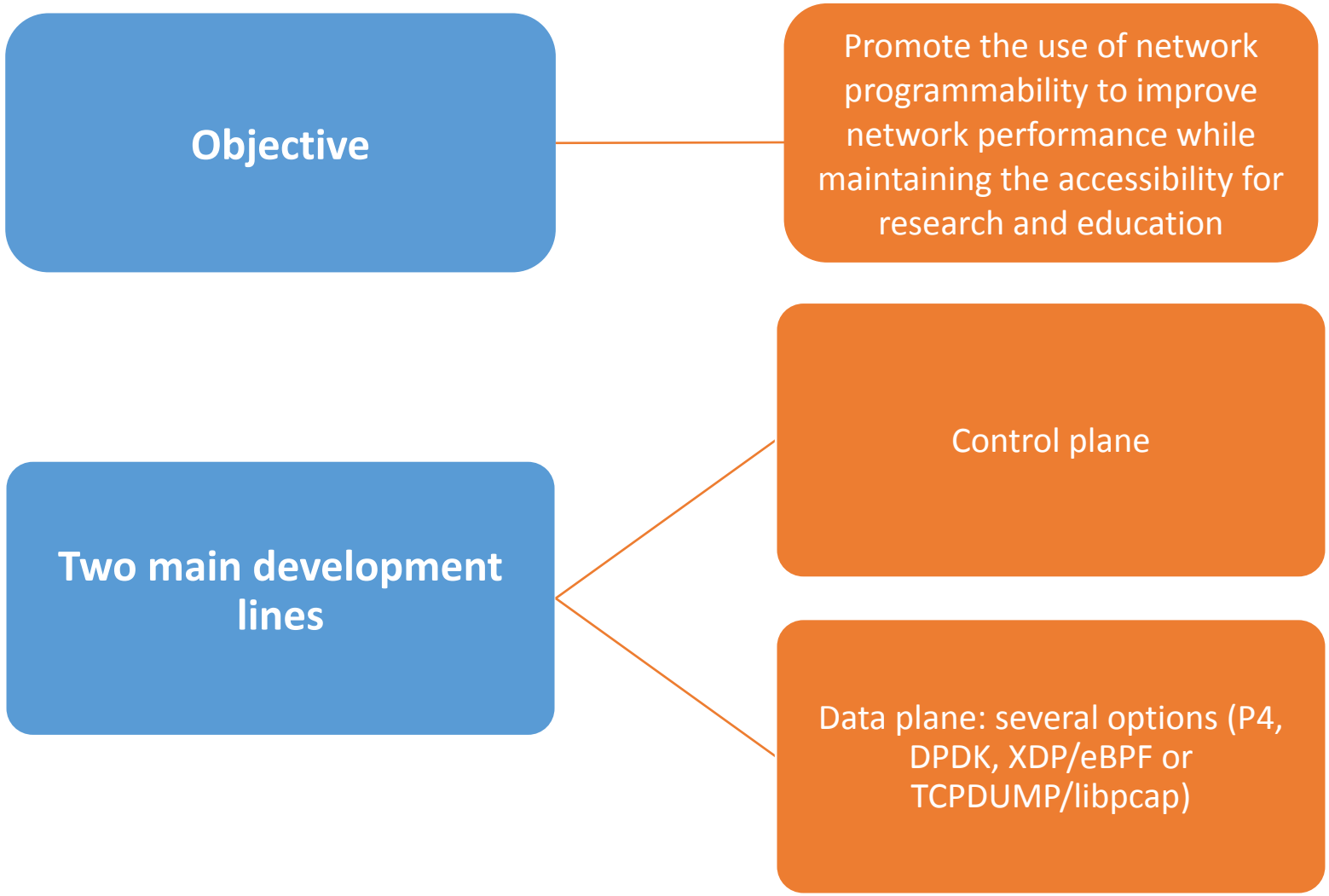
The group focuses on creating an Open Source routing software platform

Information and support in the website including:

General information
Installation guides
Use cases & Tutorials

https://docs.rare.geant.org/

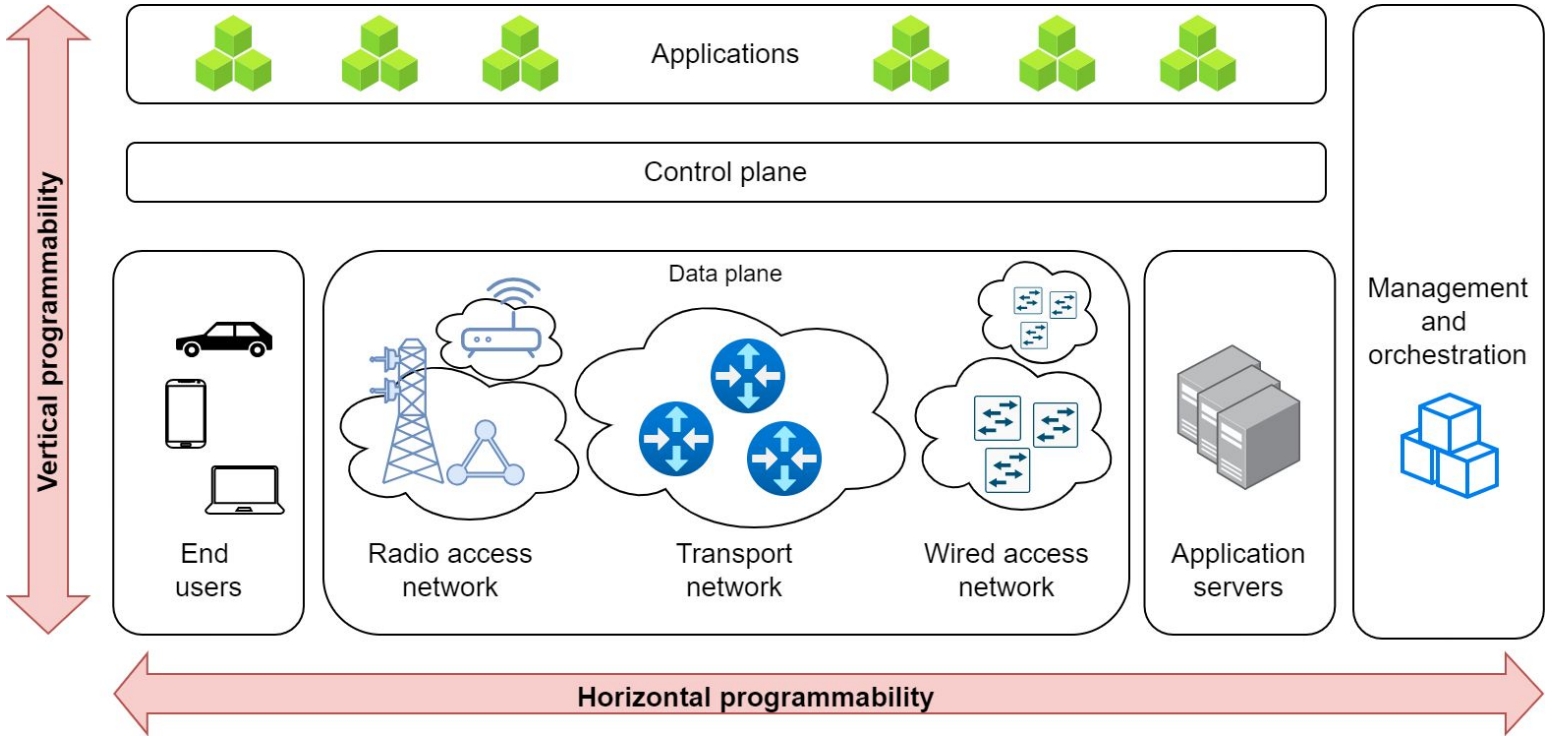
Aim of the task



Aim of the task

Introduction to **network programmability**

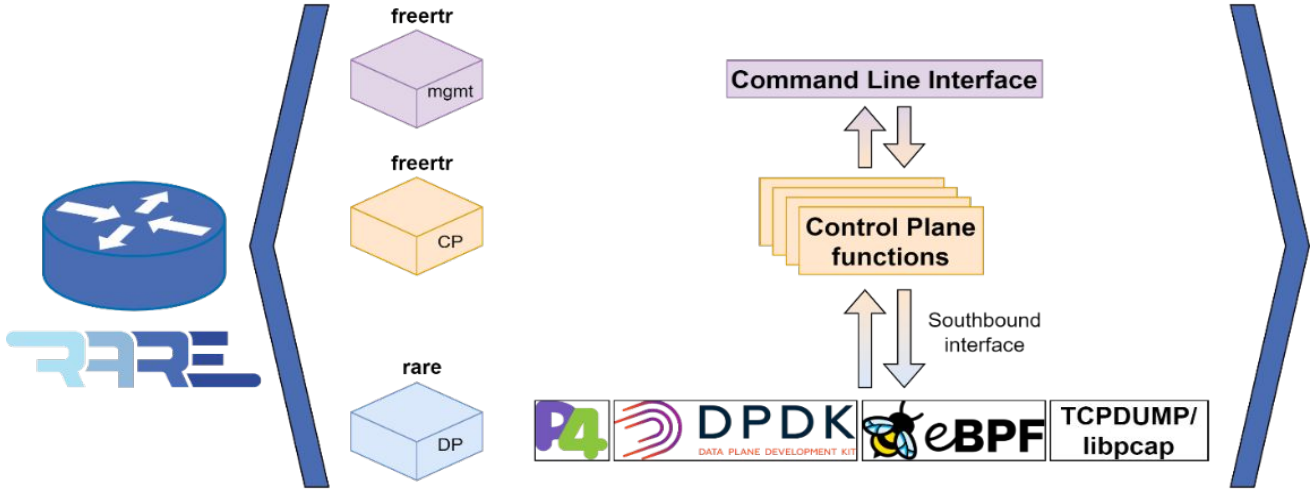
- Manage and control a network through software applications rather than relying on manual configuration
- Automation tools and programming techniques to make networks more flexible, scalable, and efficient



RARE router

Router for Academia, Research & Education (RARE)

- Production ready routing and switching functionalities
- Control and data plane separation
  - Control plane: ***freertr***
  - Data plane: ***rare***
    - Programmable data plane
    - P4, DPDK, XDP/eBPF, libpcap



RARE router

Functionality

- Routing & forwarding
  - IP, LLDP, VLAN, MPLS, BGP, OSPF, BFD
- Tunneling
  - GRE, L2TP, VXLAN, GTPv1, IPsec, MACsec, wireguard, openvpn
- Management
  - Telnet, SSH

Performance

- Tested at **100 Gbps** (Tofino ASIC)
- Tested at **400 Gbps** (Tofino2 ASIC)

Latest activities

- Anti-DDoS use case
- 5G/UPF use case
- Anomaly detection use case
- Deployments/Hardware/Packaging

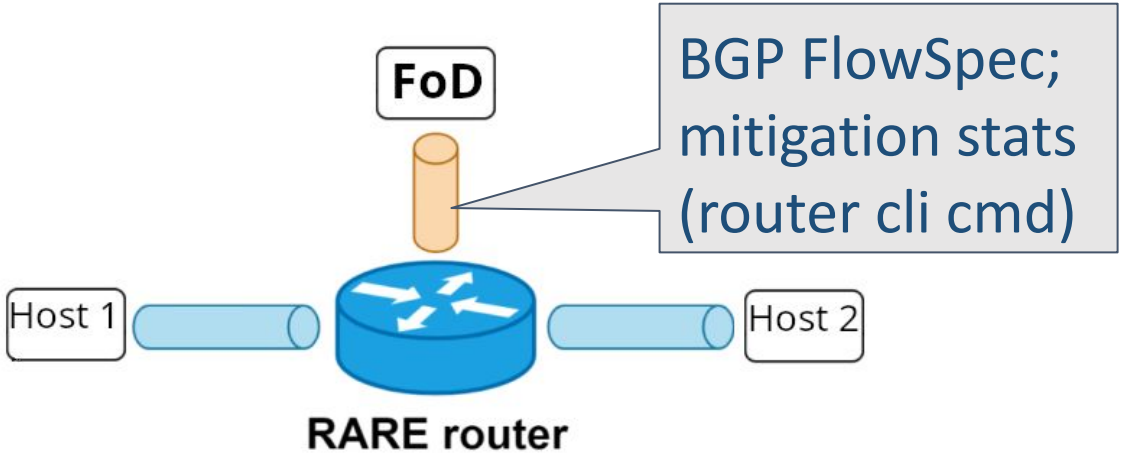
Anti-DDoS

- General Objective: Protect critical network infrastructures from DDoS attacks within multi-domain environments
- In GÉANT two open-source software projects for DDoS detection and mitigation already exist and are actively developed:
  - Firewall on Demand (FoD): DDoS mitigation only
  - NeMo: DDoS detection and mitigation
- Actual installation and testing (and even development testing) of both software products is not uncomplicated
  - require at least one router supporting FlowSpec
  - connected to network where DDoS is happening or at least emulated
- First Goal: Use RARE platform to make testing of both uncomplicated

Anti-DDoS (FoD)

- Objective: Integration of FoD with RARE platform

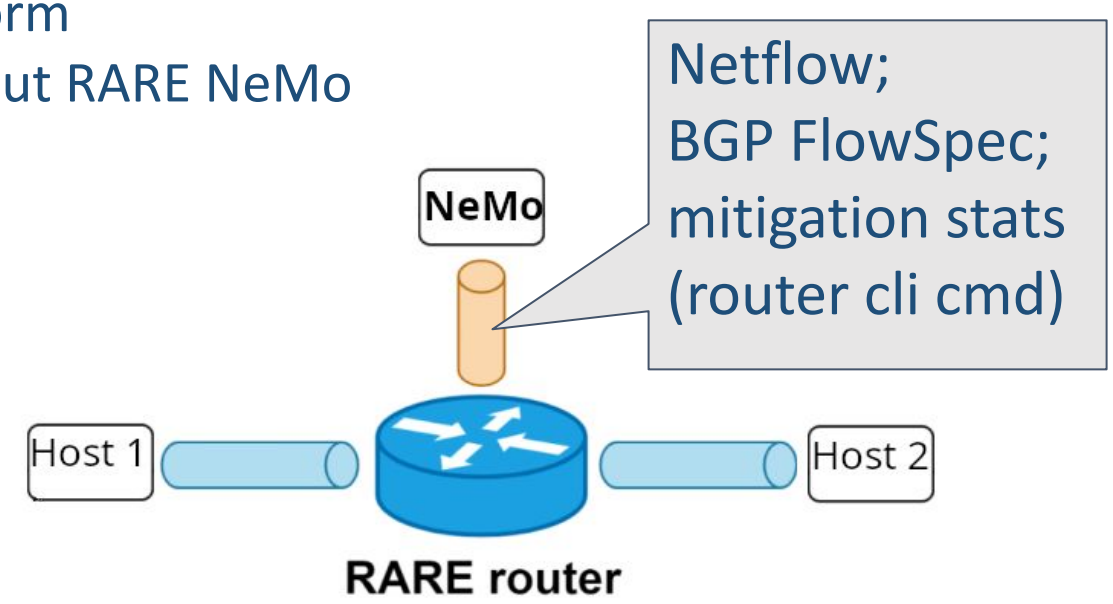
- Current Result: RARE FoD
  - Uncomplicated setup, installation, configuration and testing of FoD with Test-DDoS network based on RARE platform
- Current Result: Explicit, automated demonstration of DDoS mitigation in RARE FoD



Anti-DDoS (NeMo)

- Objective: Integration of NeMo with RARE platform

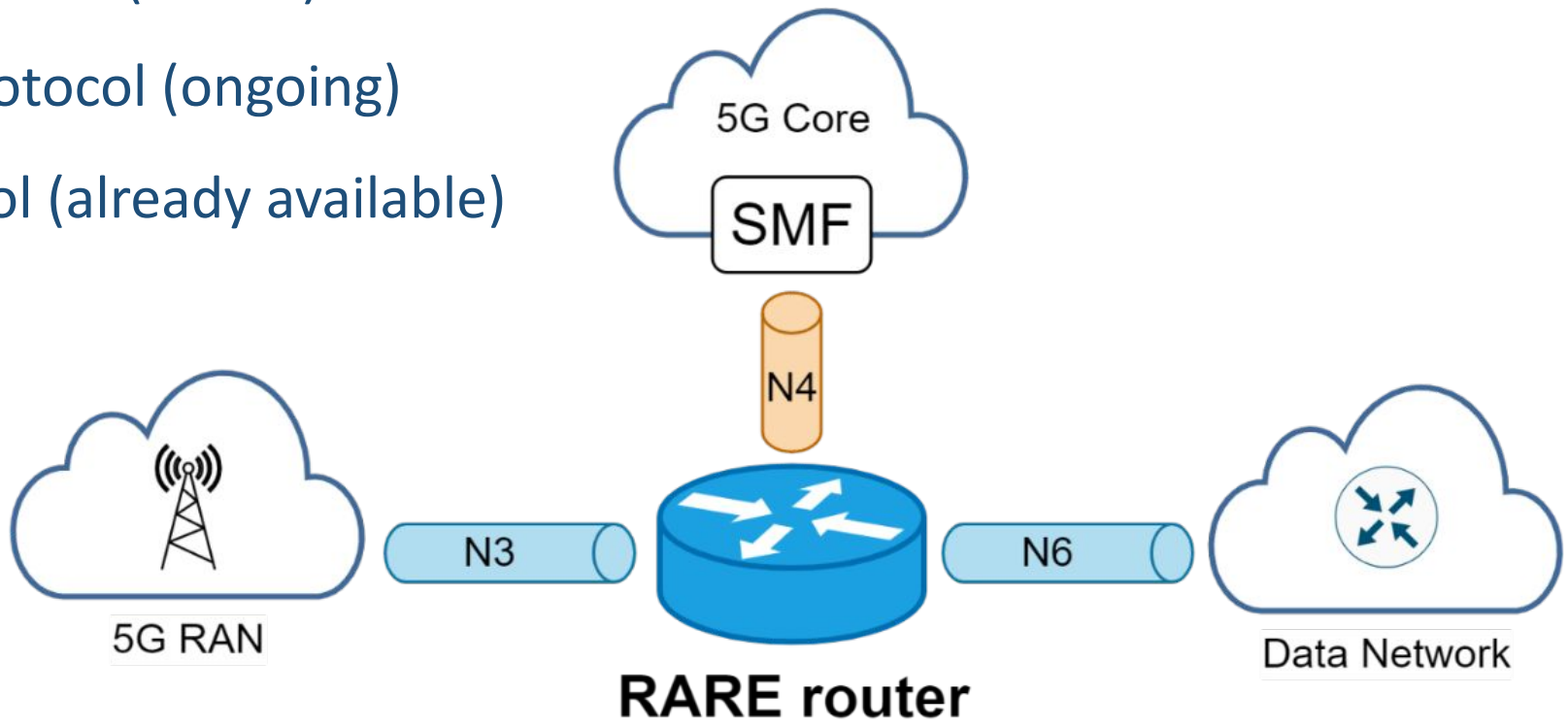
- Current Result: RARE NeMo
  - Uncomplicated setup, installation, configuration and testing of NeMo with Test-DDoS network based on RARE platform
- Work in Progress: GEANT Moodle course about RARE NeMo



5G/UPF

Implementation of the User Plane Function (UPF)

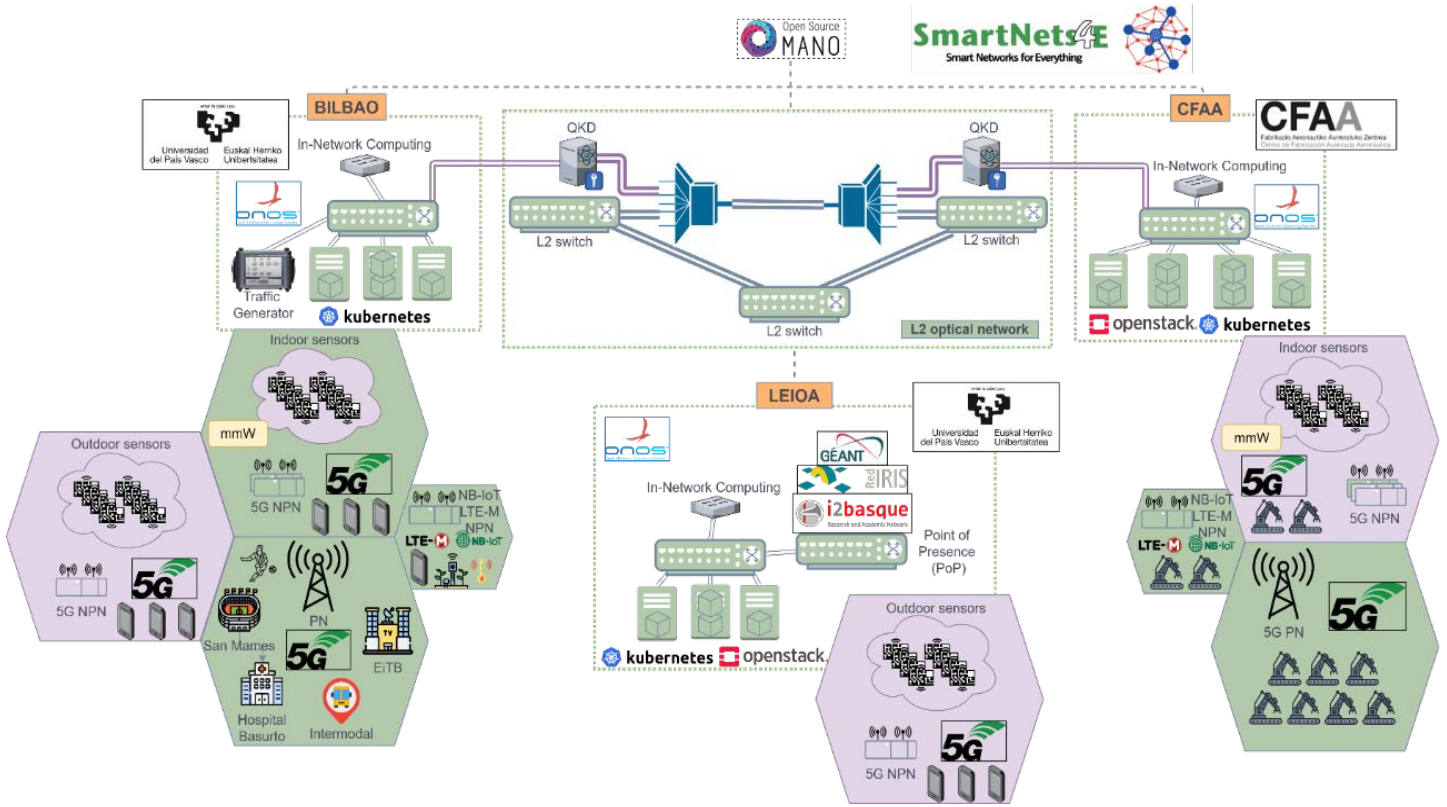
- **N4** interface: **PFCP** protocol (tested)
- **N3** interface: **GTPv2** protocol (ongoing)
- **N6** interface: **IP** protocol (already available)



5G/UPF

Smart Networks for Everything (**SmartNets4E**[1])

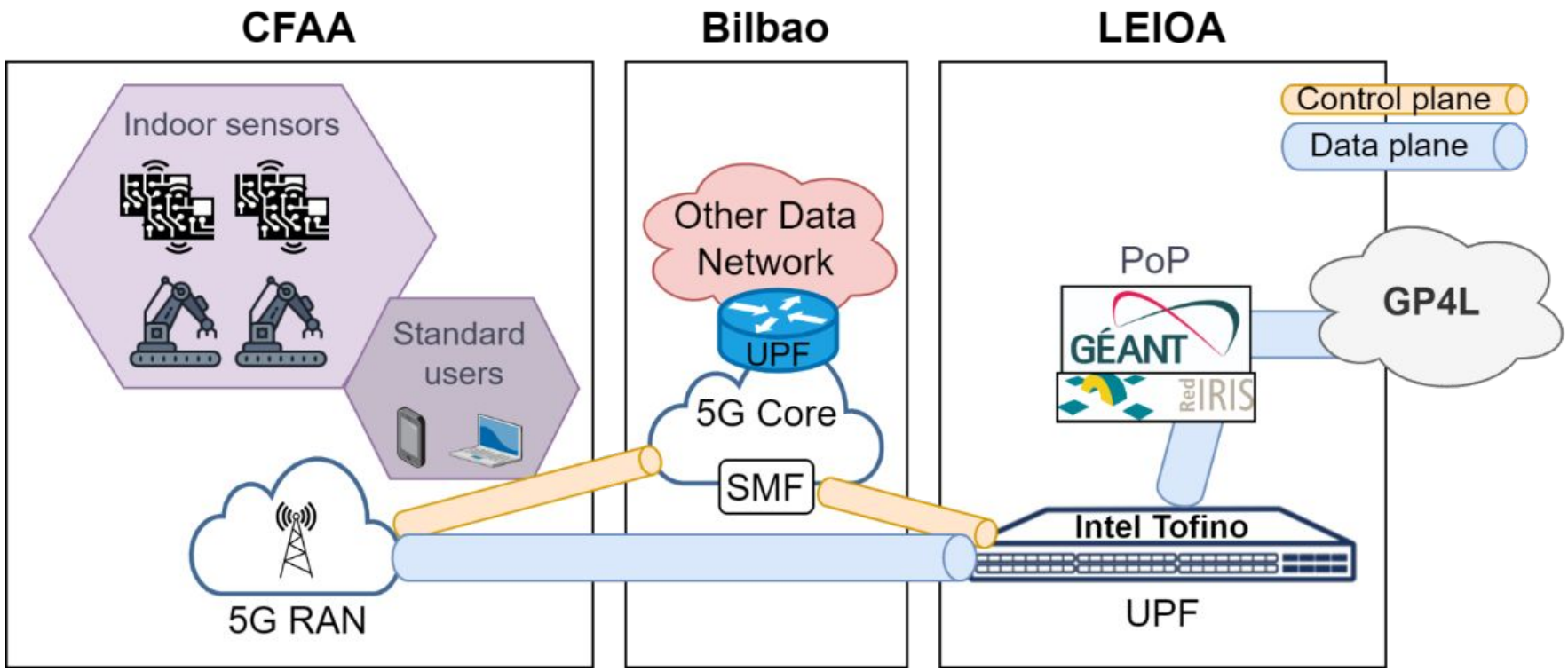
- An infrastructure for network research
- Three nodes interconnected at 10/100G
- Research resources for 5G/6G in different verticals
  - Advanced manufacturing (CFAA node)
  - Health, education, transportation and mobility (BILBAO node)
- Integrated into the ESFRI SLICES-RI
- Collocated with GÉANT's PoP (LEIOA node)



5G/UPF

The role of RARE-UPF

- The scenario in our research infrastructure



P4 and Tofino for Anomaly Detection

Use case:

- Implement machine learning in DPP/P4 for Anomaly Detection.
- Idea: Use a coarse filter for further analysis

Implementation with Planter

- Modular framework for realizing in-network machine learning algorithms.
- Activation functions using M/A tables

Training Dataset:

- CIC-IDS-2027 (labelled)
- Best quality despite not new

Performance testing

- 100G Ethernet testing with insignificant loss

Detection performance anno 2025:

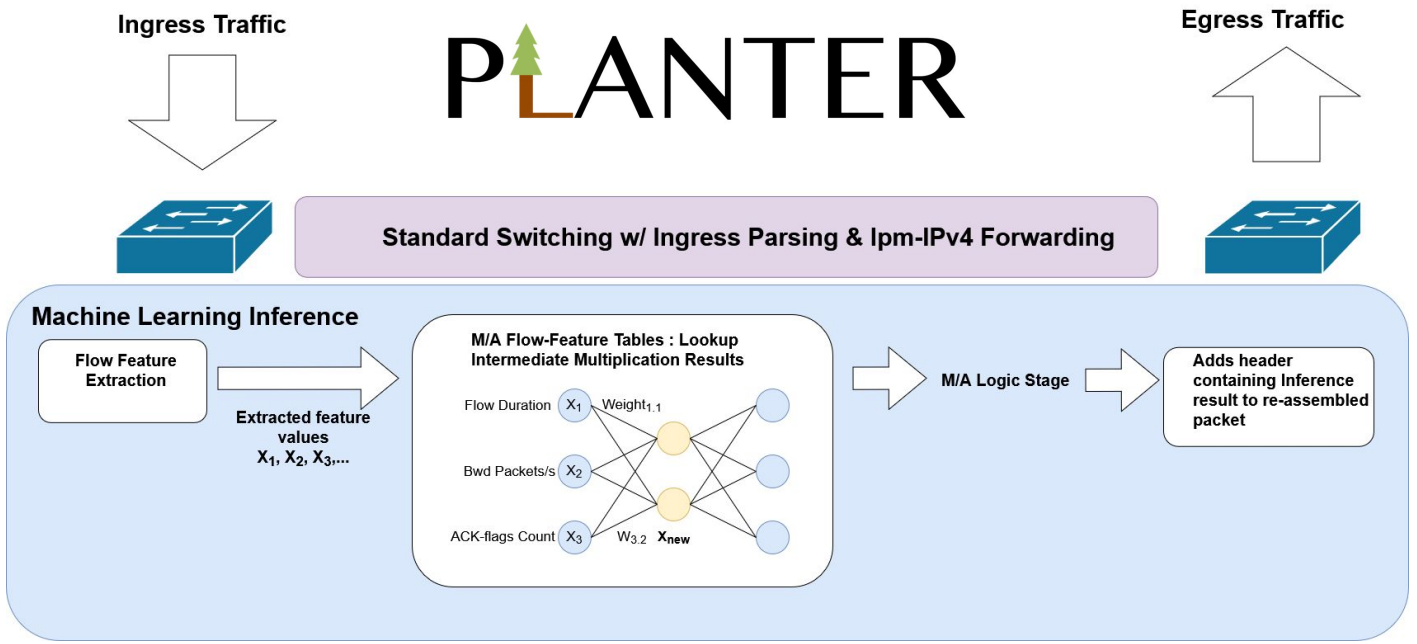
- Great room for improvement

Reasons for bad detection capability:

- Limited number of supported features (M/A stages)
- Flow feature extraction occupy some M/A stages
- Collisions in hash tables due to 100k+ flows

Next steps:

- Investigating other frameworks
- Focus on feature extraction in P4
- Identify/generate updated datasets



Deployments/Hardware/Packaging

RARE on the Tofino platform leverages the Nix package manager to provide

- reproducible builds
- one-line deployments with ONIE
- seamless upgrades and rollbacks
- independence of the system's native package manager
- easy-to-use P4 development environments
- drastic reduction of support for third-party installations of RARE

Ongoing work to move from the EOL Intel SDE to its open-source successor Open P4 Studio.

Future directions

- Ongoing support to R&E community
  - Pursue RARE/freeRtr effort (one yearly snapshot) with Open P4 SDE
  - Integrate new control planes
    - SONIC control plane study
    - SAI to unlock access to various ASIC dataplane
    - Micro control planes
- Kernel-bypass technologies
  - VPP/DPDK, eBPF/XDP
- New use cases
  - Quantum-based security
  - FlowSpec v2
- Participation and contribution to standardisation activities
  - Support/test new drafts based on R&E needs
  - Contribute to new draft
- Community development
  - Documentation
  - Relevant event participation
  - Social media

Thank You

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www.geant.org

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